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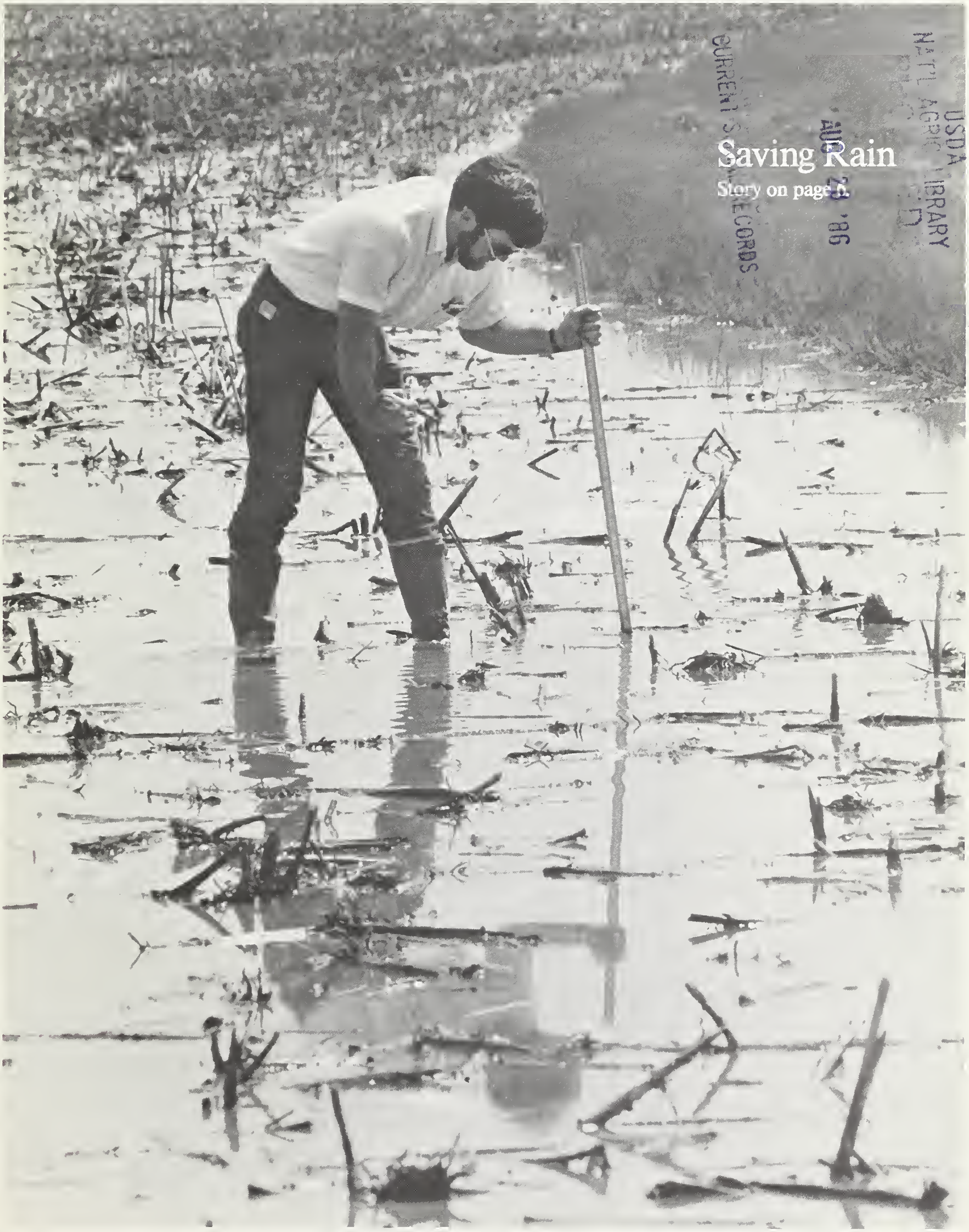


E.F. Knipling—a Pioneer in Insect Control

When Edward F. Knipling first thought of turning normal insect reproduction into a weapon against the screwworm fly, he was met with more than a little disbelief.

Knipling developed his revolutionary theory, later called the sterility principle, in the 1930's while combating the screwworm fly for USDA's Bureau of Entomology and Plant Quarantine at Menard, TX. At that time, screwworms were a major killer of livestock and wildlife. Flies multiplied unchecked by laying their eggs in open wounds.

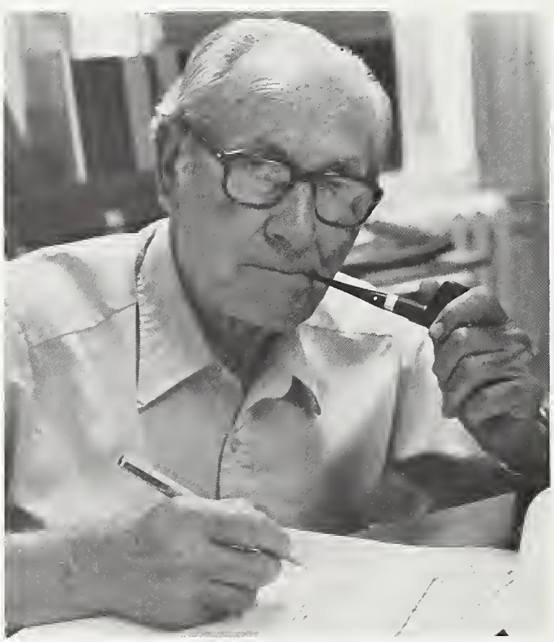
Based on his studies of screwworm behavior, Knipling thought infestations of the pest could be eradicated by overwhelming it with laboratory-reared male flies that had been sterilized somehow. The sterile flies would ensure numerous barren matings.

For years, people scoffed at this "crazy" theory. Throughout it all, Knipling maintained confidence in an idea based on a sterilization method that did not exist. His screwworm work was interrupted for more than a decade, by World War II among other things. Then, in 1950, he learned from Nobel Laureate Hermann J. Muller about the possibility of using x rays and gamma rays to sterilize the flies.

In 1954, USDA scientists working under Knipling's direction demonstrated the idea would work by releasing gamma ray-sterilized flies on Curacao, a Caribbean island. Within about 3 months, the screwworm population was annihilated.

By 1959, screwworms were eradicated from the southeastern United States and by 1966 were strongly suppressed in the Southwest, through cooperation with Mexico. The pest has since been eradicated from all of the United States and from most of Mexico. The savings to ranchers amount to hundreds of millions of dollars a year.

But you'd have to be in the livestock business to fully realize what this accomplishment has meant. As Ed Ketchum, president of the Southwest Animal Health Research Foundation, tells it: "Knipling completely changed the way ranchers operate. We wouldn't know what do with a cow infested with screwworms now because we haven't seen any cases in so many years. Cowboys used to ride the range every other day searching for infested cows. They'd put medicine on the wound to repel the flies and kill the worms, but the treatment only worked a day or two, at best. Now they don't have to, and we couldn't afford it anyway. I don't know of any other program so supported by ranchers or of anyone who has had such an impact on the industry."



Though retired, Knipling serves as a pest management collaborator for ARS at Beltsville, MD. (0686X756-34a)

Spurred by this success, Knipling turned his inventiveness to possibilities for controlling other formidable pests. Considering a variety of techniques—control with parasites and predators and with insect attractants and repellants, as well as sterilization—he proposed new ways to control: Mexican, Mediterranean, and oriental fruit flies; pink bollworms; codling moths; boll weevils; gypsy moths; mosquitoes; tsetse flies; ticks; and many other pests.

Although he is best known for his efforts to eradicate the screwworm, Knipling's greatest contribution has been his leadership in advancing, to an unprecedented extent, the science and technology of insect control. He served as director of entomology research at the Agricultural Research Service from 1953 to 1971. Under his leadership, most of the agency's entomology research was redirected from the development of nonselective insecticides to biological and other selective controls. Much of the redirection had been done by the time Rachel Carson published her landmark book on the dangers of broad-spectrum insecticides, "Silent Spring" (1962).

For his leadership and scientific accomplishments, Knipling has received many awards nationally and internationally. Most recently, ARS named him the first inductee into the agency's Scientific Hall of Fame. A plaque honoring Knipling will be on permanent display in the planned National Visitor Center at Beltsville, MD.

With this award, ARS officially honors its outstanding and highly successful scientists whose careers exemplify their deep commitment to serving the public through agricultural research. Knipling is an excellent choice as the award's first recipient. No one else has made such contributions. It's not only the payoffs such as the screwworm eradication that are important, but the fundamental concepts behind those payoffs. Those same principles can be applied to a dozen or more other major pests, some of which are even more important to the agricultural economy of the United States than the screwworm was. That's Knipling's legacy to ARS: a challenge to use his concepts to control these pests within the next 20 years.

Terry B. Kinney, Jr.,
Administrator

Agricultural Research

COVER:
As part of the Agricultural Research Service's ongoing efforts to assist Great Plains farmers who return to dryland farming, biological aide Joseph Bryan checks depth of water conserved with a level terrace system.
Terraces not only reduce soil erosion on dryland farms but also allow storm water to soak into the soil instead of running off the land. Story begins on page 6. (0686X703-27)

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DEPARTMENTS

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Sore Muscles: Studies Offer New Clues

After exercise, why do one person's muscles ache and another's feel fine?

One group of volunteers breezed through a 45-minute bout on a stationary bicycle, reporting almost no soreness in their thigh muscles afterward. But another group found it hard to move normally a day or two later.

At first glance, the results were predictable: Those in the first group were distance runners who trained daily; those in the second group were sedentary men who exercised infrequently. What is new is that through such studies, scientists are beginning to understand why training makes a difference in the body's response to exercise.

Muscle damage causes the soreness 24 to 48 hours later, and several studies now point to the "eccentric part of exercise as the culprit," says William J. Evans, who conducted the exercise study at the Agricultural Research Service Human Nutrition Research Center on Aging at Tufts University in Boston. Eccentric exercise occurs when muscles lengthen as they produce force, as in lowering a weight or walking downstairs.

A volunteer exercises at the Human Nutrition Research Center on Aging while technicians monitor his heart rhythm and oxygen consumption. (0286X130-32)

Trained athletes don't suffer from sore muscles because their muscles have "learned" how to stretch without tearing and their bodies are already geared up to repair any damage quickly, says Evans, whose research is funded by the Agricultural Research Service. His studies show that individual muscle fibers tear apart at a "weak link" known as the Z disk.

According to Evans, the five sedentary volunteers responded to this damage much like they would to an infection—by producing large amounts of interleukin-1, a polypeptide known to be part of the body's immune system. "Interleukin-1 apparently triggers a sequence of events leading to repair of damaged muscle fibers," he says.

"Before muscles can be repaired," he says, "damaged proteins have to be broken down and disposed of and new proteins synthesized." Blood and urine samples taken during the exercise study showed that "muscle damage was more severe in the sedentary men and the repair process was much slower."

The runners in the study maintained high blood levels of interleukin-1, which did not significantly rise after cycling for 45 minutes. "In other words," Evans says, "the runners have the jump on muscle repair, if repair is needed."

His laboratory is looking into how this happens and how the muscles in elderly men repair the same type of damage. The answers may take several years of research because the system is complex.

"Unfortunately," he says, "regular eccentric exercise doesn't protect other muscles in the body against damage. If a runner were to chop wood for several hours, he or she would experience just as much soreness in the upper body as the sedentary person."

"Eccentric exercise requires less energy than other exercise, but its delayed effects may cause greater changes in body metabolism and damage to muscle tissue," Evans says.—By **Judy McBride,** ARS.

William J. Evans is at the USDA-ARS Human Nutrition Research Center on Aging, 711 Washington St., Boston, MA 02111. ■

Sugar Byproduct Removes Bitterness From Grapefruit Juice

A byproduct from the manufacture of corn sweeteners has the unusual ability to trap and remove the sources of bitterness in grapefruit juice and navel orange juice, reports a chemist with the USDA's Agricultural Research Service in Winter Haven, FL.

The trapping agent, says the scientist, is cyclodextrin polymer, a sugar byproduct that is chemically treated, or polymerized, to make it inert and insoluble in water.

Once treated, the substance, which resembles fine, white sand, can be used as a "bitterness filter" for citrus juice, according to Philip E. Shaw.

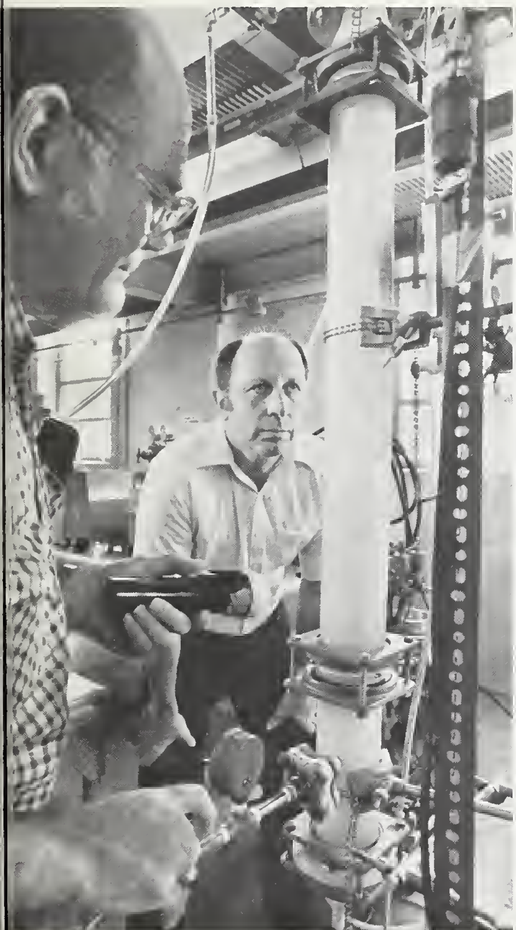
In Shaw's laboratory model, grapefruit juice is pumped through 18 inches of cyclodextrin contained in a glass column 3 inches in diameter. The cyclodextrin is agitated to permit the citrus pulp to pass through along with the juice.

"The big molecules of the sources of bitterness in grapefruit juice—limonin and naringen—get physically stuck inside the holes of the donut-shaped molecules of cyclodextrin," explains Shaw, "where they are held in place by a weak chemical bond."

Enough of the bitter substances are taken out, he believes, "to make the juice much more acceptable to consumers."

He adds that vitamin C, sugar, and other nutrients in the juice pass right through the holes.

When the cyclodextrin has ab-



Scientists C.W. Wilson (left) and Philip Shaw watch as early season grapefruit juice is pumped through a tube, where the juice's bitterness is removed by donut-shaped molecules of cyclodextrin. (PN-7206)

sorbed all the bitterness it can, the limonin and naringen can be washed out with a weak alkaline solution and the cyclodextrin cleaned, sterilized, and used again.

"While many consumers of grapefruit juice undoubtedly enjoy some degree of bitterness," the research chemist says, "the chief concern of the industry is with early season grapefruit. These are typically so bitter that their juice has to be mixed with juice from midseason and late grapefruit to make it palatable."

"This is a costly operation, since it requires holding and refrigerating large quantities of juice over several months."

One bitterness agent in grapefruit—limonin—is also found in the juice of navel oranges, according to Shaw.

Approval of the federal Food and Drug Administration will have to be obtained before cyclodextrin polymer can be used commercially to debitter juice.—By **Hubert Kelley,** ARS.

Philip E. Shaw is at the USDA-ARS Citrus and Subtropical Products Laboratory, P.O. Box 1909, Winter Haven, FL 33883-1909. ■

Juice Bitterness May Be Blocked With Hormones

Natural bitterness in juice from navel oranges may someday be prevented by feeding orange trees small doses of natural plant hormones known as auxins.

Agricultural Research Service chemist Shin Hasegawa, at Pasadena, CA, has found auxins that are expected to successfully block formation of a compound that leads to bitterness in juice from navel oranges. Normally, the juice turns bitter just hours after it is extracted. Bitterness is not a problem, however, with navel oranges that are eaten fresh.

The auxins work by inhibiting production of nomilin, a compound needed for production of a second chemical—limonin. It is the limonin that causes extreme bitterness in navel oranges, especially early season fruit.

Earlier work by Hasegawa and colleagues provided new details on how limonin and nomilin are formed in citrus cells and led to the experiments on how to block this natural chemical process.

In greenhouse tests, the scientists fed tiny quantities of auxins to lemon seedlings for 3-day periods. The applied auxin blocked up to 97 percent of nomilin production. The auxins were just as effective on a few older, fruit-bearing trees.

Although Hasegawa used lemon trees for the experiments, he expects similar results in planned experiments with oranges because the bitterness-formation process is the same in both fruits. He began the tests with lemon trees because, in California, these trees bear fruit almost year-round.

The findings could lead to an expanded market for juice from California and Florida navel oranges. Currently, only limited amounts of navel orange juice are mixed with juice from other oranges. The bitterness problem costs California navel orange growers an estimated \$6-\$8 million each year in lost juice sales.

Most commercially processed orange juice has no more than 2 parts per million of bitterness agents, according to Hasegawa. Valencia orange juice has less than 2 parts per million of these bitterness compounds, while navel orange juice can easily contain from 15 to 25 parts per million.

The auxin approach differs from other methods proposed in recent years for debittering juice from navel oranges and other citrus because it focuses on changing the tree's chemical makeup. In contrast, other approaches require treating freshly squeezed juice with bacteria, resin, or other materials. [*See "Sugar Byproduct Removes Bitterness" on page 4.*]

If successful in field tests, auxins may offer the advantages of low cost and convenience. One of the auxins tested, 1-naphthaleneacetic acid, is safe, inexpensive, and readily available. It is routinely used on apples, pears, and grapes.

Field tests should indicate how often the auxin should be applied, and the ideal amount and concentration to use. "We'll also find out if there are any negative effects on the tree or its fruit," Hasegawa says.—By **Marcia Wood,** ARS.

Shin Hasegawa is at the USDA-ARS Fruit and Vegetable Chemistry Laboratory, 263 South Chester Ave., Pasadena, CA 91106. ■

Shutting Off the Water

Water content of soil below bench terraces is measured periodically by Larry Fulton, ARS technician at Bushland, TX. Aim of the work is to develop better cropping and terracing systems that conserve water, increase yields, and protect soil from erosion. (0686X711-11)

"I didn't water my crops last year, and I won't water them this year," says Robert Jacobson, a farmer in the West Texas Panhandle.

Jacobson wouldn't have considered saying that a few years ago. When he and his father started irrigating their wheat in 1954, they found that they could afford supplemental irrigation on more than 2,800 acres.

But 2 years ago, changes in the economics of farming—costs vs. income—prompted Jacobson to take a hard look at the wisdom of irrigating at all. When he examined all the options, he decided to return to dryland farming.

Before the oil embargo of 1973, says Bobby A. Stewart, an Agricultural Research Service soil scientist at Bushland, TX, natural gas used to pump irrigation water cost only 37 cents for 1,000 cubic feet. By 1985, the cost had climbed about 1,100 percent, to $4 per 1,000 cubic feet.

On the other hand, as recently as 1982, the average price farmers in the Texas High Plains received for a bushel of wheat was $3.61. By June 1986, the price had fallen to $2.20-$2.45, down more than 35 percent from 4 years ago.

"Faced with a combination of low commodity prices, high fuel costs, and deeper wells, it isn't hard to see why farmers like Bob Jacobson decided that they had better learn to survive without irrigating."

—Soil Scientist **Bobby A. Stewart**

Furthermore, many irrigators in the Great Plains pump their water from the vast Ogallala aquifer, an underground reservoir that stretches from South Dakota to Texas. While only 5 percent of the 3.2 billion acre-feet of water in the Ogallala has been tapped so far, hydrologists say that Texas has pumped

nearly a fourth of the water from its portion of the Ogallala. As the water table falls beneath the High Plains, farmers have to use more and more fuel to pump the same amount of water up to ground level.

Every year, more farmers join Jacobson in returning to dryland farming in this region, where the major dryland crops are winter wheat, cotton, and grain sorghum. Irrigated farming zoomed after the end of World War II, and irrigated acreages in the southern High Plains kept climbing until the peak year of 1978. After that, they began to decline. Texas had a high of 6.9 million acres of irrigated farmland in 1978; by 1984, the acreage had fallen to 4.9 million. It was a similar story in New Mexico, which had 891,000 irrigated acres in 1978 and only 674,000 acres in 1984. Oklahoma had 602,000 irrigated acres in 1978 and 439,000 acres in 1984—the lowest irrigated acreage since the mid-1960's.

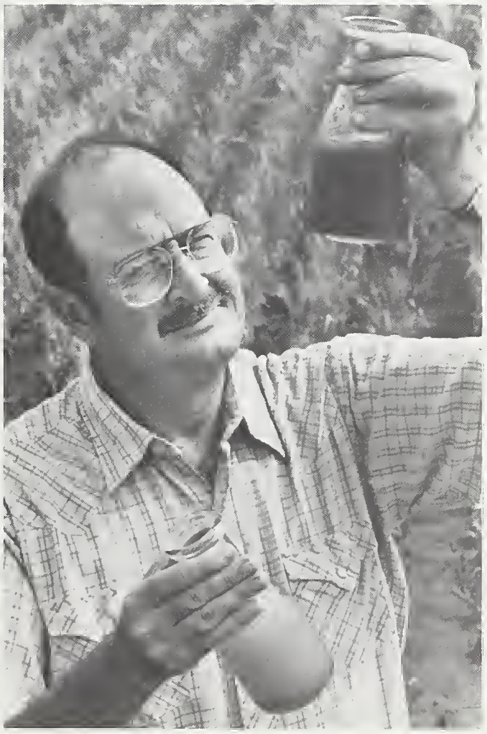
And the downward trend continues because of dollars and cents reasons.

"Obviously, there are risks inherent in abandoning irrigated farming in a region with uncertain rainfall, like the southern High Plains," says James F. Parr, the ARS national program leader for dryland farming. "Rainfall in any given year can range from 10 inches or less up to 30 and more. But I think we know enough about farming this region today to avoid another Dust Bowl, even after a prolonged drought."

Parr is convinced that the use of modern farming techniques, many of them developed by ARS researchers throughout the Great Plains, will help farmers avoid the mistakes of the past.

"When cropping started in the Plains, farmers used the same methods that they were familiar with in the wetter states to the east. This worked when there was adequate rainfall, but when the dry years came, it was a disaster," he says.

"We exploited the Great Plains for years because we didn't know how to manage them," Parr says. "Today we know a great deal about soil and water management that we didn't know then,



Above: A recent convert to dryland farming in the Texas High Plains, Paul Jacobson (on spray rig) applies herbicide on no-till field before planting grain sorhgum. His father, Robert (right), discusses water-saving effects of crop residues with O.R. Jones of ARS. (0686X707-17A)

Left: O.R. (Reggie) Jones, ARS soil scientist, examines runoff, dark with sediment, from conventionally tilled field. The other bottle, practically sediment free, contains runoff from no-till field. (0686X706-31)

(PN-7214)

The Ogallala Aquifer

It's ironic that beneath the Dust Bowl lay a water reservoir slightly larger than all of California.

Although the technology needed to tap it for irrigation wasn't there when needed most, the Ogallala aquifer has been heavily pumped since the drought of the 1950's.

The Ogallala is actually water that has seeped into what was, more than 2 million years ago, a seabed. The bed—deposits of sand and gravel eroded from the Rocky Mountains—extends from South Dakota down to Texas and New Mexico. It is made up of three somewhat connected geologic units—the Brule Formation, the Arikaree Group, and the Ogallala Formation—with the Ogallala being the largest.

The aquifer's thickness varies from less than 50 feet in the southern High Plains of Texas to as much as 1,200 feet in Nebraska.

The region over the Ogallala is generally semiarid, so the ground water recharge from precipitation is extremely small, estimated to be one-half to 2 inches a year. No water flows into the Ogallala from outside the region.—
D.C. ■

Fifty years old but still effective against wind erosion on sandy soil is the "West Texas sandfighter." As tines on the machine cut through wet soil, they throw up clods that are too big to blow away. Clods on a soil's surface can cut erosion rates by 75 to 80 percent. (0686X693-21)

and we have developed effective practices and the mechanisms for applying that knowledge. We also have a better understanding of wind erosion and how to prevent it."

It is no single discovery that makes possible a profitable return to dryland farming. Rather, it is a combination of better crops, better farming methods, and better resource management.

O.R. (Reggie) Jones, a soil scientist at Bushland, in the Texas Panhandle, says that "the biggest single factor in preventing another Dust Bowl is what we have learned about water conservation, including leaving crop residues on the surface of the soil to improve rainfall infiltration and slow down evaporation. But we also understand the weather and climatic patterns much better and we have adapted our methods to those variables. And we have better crop varieties.

Another factor that seems more important every year is weed control with herbicides. Weeds are a big competitor for water, and chemical weed control is contributing a lot to increased yields."

Here are some of the specific techniques developed through years of research and field trials that are encouraging the region's farmers to assume the risks of dryland farming:

- *Water conservation and conservation tillage.* The main emphasis of dryland agriculture is to use farming methods that retain rainfall, reduce evaporation, and take advantage of the

rainfall patterns. Where research is perhaps paying off the most, Jones says, is in helping farmers stop the rain from running off the land.

Leaving crop residues on the field instead of plowing them under protects the soil surface, reduces evaporation, and keeps soil pores open so water can infiltrate.

According to Jones, in comparison with tilling a field clean, stubble mulch tillage—leaving crop residues on the field after harvest—conserves 20 percent more water and soil. On fields in the Texas High Plains, stubble mulching increases wheat yields about 12 percent over conventional tillage. And higher yields lead to more residue on the surface for the next crop.

• *Terraces and dikes.* Bench terraces are also used on gentle slopes to conserve water that would otherwise run off and be wasted. Designed like stair steps, the terraces catch rain water in May and June and hold it in the topsoil so the plants can use it in July and August. Jones says large benches conserve enough additional water that farmers can plant a crop each year on the level bench.

Furrow dikes are small, temporary soil-packed dams across the furrows to trap rainfall and keep it from running off. They were used in the Great Plains in the 1930's but were abandoned for several reasons, including poor weed control and erosion when dams washed out. Agency engineers helped revive the practice in 1975, by designing better equipment to make the dams and using the dikes in summer crops when the potential for runoff is highest. In the southern High Plains, there are over 2 million acres with furrow dikes.

• *Weed control.* In reduced tillage or no-till systems, farmers use herbicides to prevent the growth of weeds that would steal away scarce water. Herbicides developed since the late 1960's now allow farmers to grow crops in rotations with fallow periods. In the southern High Plains, including a fallow period in crop rotations can markedly increase the amount of water stored in the soil. A rotation of dryland winter wheat/fallow/grain sorghum, with no-till after sorghum, adequately maintains residues, and compared with tilled-field tests, yields are just as high for wheat and 20 percent higher for grain sorghum.

• *The "Sandfighter."* Agency researchers have one simple answer to soil-blowing wind—create rough clods on top of the soil to make the surface too heavy for wind to lift away. Surface clods resist wind erosion, help anchor mulches, slow runoff water, provide shade, and physically protect young plants. But rain falling on bare soil smooths out the surface. When the soil dries, particles of sand are picked up by the wind. And wind-blown sand

Bobby Stewart, who leads the conservation research at Bushland, TX, reports that Panhandle farmers are turning to dryland farming in greater numbers as irrigation costs rise and crop prices decline. Stewart has spent his life conserving soil and water in the Dust Bowl area. (0975X1926-33)

An ARS invention provides dryland farmers with an early warning — maybe 2 to 16 weeks ahead of time — of fields that may erode in severe windstorms. The Big Spring (Texas) Dust Sampler, invented by ARS scientist D.W. Fryrear, detects subtle changes in erosion patterns, giving farmers time to protect endangered fields by using corrective tillage implements. (0686X696-31A)

ARS soil scientist Jean Steiner checks instrumentation used for evapotranspiration research on dryland wheat. Precise field measurements help researchers develop cropping systems with improved water-use efficiency. (0686X710-1)

Right: James Parr, ARS scientist and authority on dryland farming, studies new varieties of drought-resistant millet. Parr is convinced that another Dust Bowl can be prevented, even after prolonged drought, with better water conservation, residue tillage, and improved dryland crop varieties. (1085X1120-33)

can destroy a crop, especially young emerging plants, in 15 to 20 minutes.

D.W. (Bill) Fryrear, an ARS research leader in Big Spring, TX, advocates the "West Texas sandfighter" to make the clods. Designed by area farmers in the 1940's, this simple implement attaches to a tractor and roughens the soil to minimize wind erosion. Its 2-inch-wide pointed metal tines compact the soil, leaving small holes about 4 inches wide by 5 inches long. In a day, one person can cover 600 to 1,000 acres. Using the sandfighter is most effective in sandy soils and right after planting crops that do not provide a good residue cover. In one study, creating surface clods reduced soil loss by 75 to 80 percent.

• *Cropping Practices.* A 3-year rotation of wheat, sorghum, and fallow also reduces soil erosion while providing crops with adequate water.

Leaving crop residues on the field instead of plowing them under protects the soil surface so raindrops can't break up and wash away soil. In field tests in Bushland, annual soil losses during the wheat crop rotation sequence were less than half a ton per acre when either no-till or stubble-mulching was used.

Crop planting times can be tied to when the rain will probably fall. Stewart says computer models could help farmers plan more effective seeding dates. A computer model takes into account each stage of a crop's life cycle and when it needs water the most. The model counts the days of higher temperatures and the probability of rainfall to suggest a planting time that matches the cropping pattern to the climate. Such planning allows the water to be used by the plants rather than be lost through evaporation.

The major drought-tolerant crops are winter wheat, grain sorghum, and cotton. But cotton, the dryland crop with potential for the greatest net return per acre, produces less residue than wheat or sorghum and has been the cause of substantial wind erosion in the High Plains.

New varieties of winter wheat, adapted to dry conditions in the

southern Great Plains, have also contributed to higher yields for dryland farmers.

Assistance to Great Plains Farmers

ARS and others communicate results of research in the Great Plains to farmers in several ways. Information and direct assistance is given through state and federal agencies, universities and Cooperative Extension agents, and local soil and water conservation districts.

Also working closely with ARS over the years has been another USDA agency, the Soil Conservation Service. This agency administers a special program established by Congress in 1956— the Great Plains Conservation Program (GPCP). This program provides technical assistance and long-term cost sharing to farmers and ranchers to help them minimize the hazards of recurring drought and soil erosion.

The 518 counties covered by the Great Plains program have 127.5 million acres of cropland, of which about 19 million acres have been covered by GPCP contracts. In the southern High Plains, most of the help to dryland farmers has been for terracing; conservation tillage practices are not approved for GPCP cost sharing in Texas and Oklahoma, but are in several northern Great Plains states.—By **Dvora Aksler,** ARS. **Sean Adams** and **Hubert Kelley,** ARS, contributed to this article.

Bobby A. Stewart and O.R. (Reggie) Jones are at the USDA-ARS Conservation and Production Research Laboratory, P.O. Drawer 10, Bushland, TX 79012. D.W (Bill) Fryrear is in USDA-ARS Wind Erosion and New Crops Research, P.O. Box 909, Big Spring, TX 79720. James F. Parr is on the USDA-ARS National Program Staff, Room 415, Bldg. 005, Beltsville Agricultural Research Center, Beltsville, MD 20705. ■

Prospects for survival were dim in 1937 for farmers in the Dust Bowl's 20 counties. Owners of this farm near Guymon, OK, threw in the towel, packed up, and headed West. (OKLA-198; USDA Soil Conservation Service photo by B.C. McLean, 10/5/37)

America's Dust Bowl of the Past

In the mid-1930s, what became known as the Dust Bowl was a relatively small part of the Great Plains, consisting of 20 counties located in the northern Texas Panhandle, Oklahoma, Kansas, and Colorado.

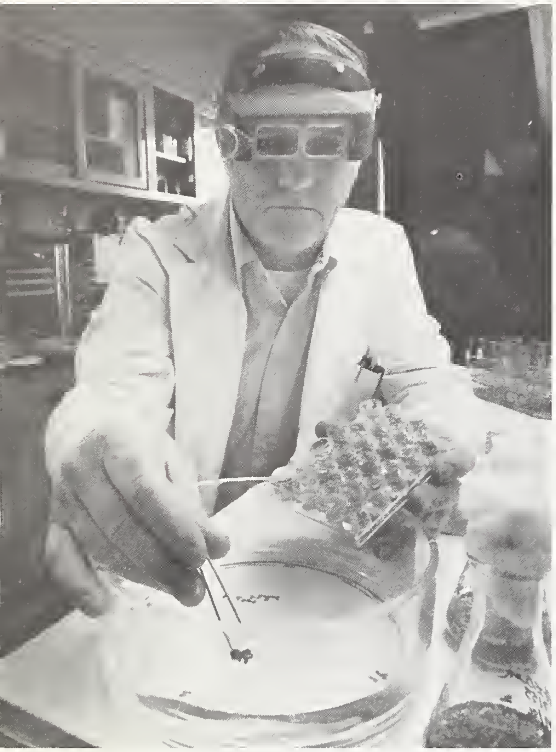
Within this small area, more than 8.7 million acres had been "severely damaged" by 1937, and an additional 7 million acres had been "damaged slightly." Hardest hit was Baca County, in the southeast corner of Colorado, with more than 1.1 million acres badly damaged by drought and wind.

Parts of the Dust Bowl appeared so desolate that some agriculturists doubted the area could ever be reclaimed, but would remain "a desert in perpetuity." USDA scientists and field workers, however, took a more positive view and set about reclaiming the area with plantings of native grasses and with other measures.

Asked why the Dust Bowl had happened, Arthur H. Joel, a spokesman for the Soil Conservation Service, said in 1937, "...the protective vegetation cover had been destroyed or seriously depleted over a large portion of the country by cultivation, overgrazing, drought, and other causes. This destruction of vegetation and the failure to provide adequate protective substitutes, such as crop stubble, crop residues, cover crops, strip crops, and suitable tillage, are generally considered to be the chief causes of the present critical condition."

In the 50 years since, conservation researchers, many centered at Bushland, TX, in the old Dust Bowl, still agree with Joel's observations.—**H.K.** ■

Duckweed May Unlock Sunflower's Secret



Plant physiologist Gerald Leather observes reduced growth and reproduction of duckweed previously exposed to plant-made herbicides known as allelochemicals. (0486X534-25)

Nature's own herbicides—allelopathic chemicals made by some plants to kill others—are getting tryouts for future roles in agriculture.

The first auditions, though, are not performed on acres of weeds, as one might expect, but on plants no bigger than aspirin tablets.

Says plant physiologist Gerald R. Leather, "The tiny duckweed is a pond-floating plant that gives scientists the economy of size needed to unravel the complex chemistry of allelopathy."

Leather, with the Agricultural Research Service in Frederick, MD, is among a small corps of scientists studying the mechanics or underlying secrets of how sorghum, sunflowers, and other plants do chemical combat with neighboring weeds.

He and plant physiologist Frank A. Einhellig from the University of South Dakota recently developed a duckweed bioassay or tissue test that for the first time will allow scientists to reliably detect the herbicide action of minute quantities of many allelochemicals.

It is difficult to study these chemicals because nature puts very little into each plant.

However, using the new test, Leather can trace the impact of an allelochemical on duckweed tissue in amounts as small as a few parts per billion. He says it's "like measuring a salinity effect of one grain of salt in a jug of water."

Not only sorghum and sunflowers, but also oats, walnut trees, some varieties of cherry and cucumber, and many weeds make forms of allelochemicals.

A popular theory among plant scientists is that many of our highly bred crop plants have lost an inherent allelopathic ability to fight off neighboring weeds for essential sunlight, soil nutrients, and water.

Some crops, such as cucumber and sunflower, the theory continues, are not as far removed from wild relatives and may have retained the ability.

Leather says that research could lead to more weed-competitive crop plants with allelochemicals added through breeding and genetic engineering.

Chemist Edward J. Saggese at the agency's Eastern Regional Research Center in Philadelphia, PA, has designed a laboratory procedure to help Leather recover active allelochemicals from extracts of plants. Saggese and fellow chemist Thomas A. Foglia use the procedure to refine up to eight chemical fractions from each extract.

Leather tests the fractions for herbicidal action on duckweed. Then the chemists further break down those fractions that have an effect into dozens of individual compounds for further testing on duckweed.

Leather's test consists of dropping a different compound into each of 30 tiny "ponds" in a wallet-sized plastic plate. Each pond contains a duckweed. "The beauty of it is that each test plate is essentially an acre of field tests in the palm of my hand," he says.

Scientists have learned that plants use their allelochemicals in various combinations and degrees.

Complicating things further, they've found that tissues of some species can contain levels of a chemical that would actually injure those plants if sprayed onto their surfaces.

For example, Leather found that sorghum can absorb and chemically tie up an allelochemical called salicylic acid that it produces. Up to a certain level, salicylic acid does no harm because the plant somehow stops the chemical from moving freely in its tissues.

"The beauty of it is that each test plate is essentially an acre of field tests in the palm of my hand."

—Plant Physiologist **Gerald R. Leather**

It may be many years, says Leather, before the work leads to commercial herbicides or to crops bred to carry allelochemicals. However, the preliminary research is beginning to answer some long-held questions.

"We are finding out why a garden pole bean refuses to climb a sunflower stalk, for instance, or why tomato vines won't grow near a walnut tree. On the farm, we are learning why seedlings of one crop may have to struggle to sprout from under the residue of a previous one."—By **Stephen Berberich,** ARS.

Gerald R. Leather is in USDA-ARS Weed Science Research, Fort Detrick, Bldg. 1301, Frederick, MD 21701. ■

Genetic Defect Could Signal Heart Disease

A newly discovered gene abnormality could prove invaluable in identifying people predisposed to heart disease, say two researchers at USDA's Human Nutrition Research Center on Aging at Tufts University in Boston.

Jose M. Ordovas and Ernst J. Schaefer, working with an international team of scientists, found the gene abnormality in 32 percent of patients with premature coronary artery disease (under the age of 60) and in 66 percent of people having too little high-density lipoprotein (HDL)—a substance in the blood that prevents clogging of the arteries. Only 4 percent of the control subjects had the abnormality.

Ordovas, Schaefer, and six other scientists in the United States, Canada, and Italy published these findings earlier this year in the *New England Journal of Medicine.* USDA's Agricultural Research Service, the National Institutes of Health, and the Charles A. Dana Foundation provided the major funding for this work at Tufts.

"If further research confirms our findings," says Ordovas, a biochemist and molecular biologist at the center's Lipid Nutrition Laboratory, "individuals having the abnormality could be identified before they develop heart disease and counseled to change diet and smoking habits to reduce risk." The ideal, he says, would be to identify the abnormality in very young children before they have developed poor dietary habits or started to smoke.

According to Schaefer, who heads the lipid lab and teaches medicine and nutrition at Tufts University, HDL tends to prevent cholesterol deposition on artery walls. So having low plasma levels of HDL increases the risk of heart disease for individuals consuming a typical American diet.

Molecular biologist Jose Ordovas (left) and endocrinologist Ernst Schaefer search for a defective gene among the small portion of the DNA in a human chromosome. The gene may help physicians identify people predisposed to heart disease. (0286X121-33)

Schaefer says the mutation is adjacent to the gene that codes for the major protein of HDL, known as apolipoprotein A-1. It's this protein that actually binds to the cholesterol, forming what is popularly known as the "good cholesterol."

"Low plasma levels of HDL-cholesterol and its major protein—apolipoprotein A-1—have been shown to be strong biochemical indicators that a person will develop coronary artery disease before age 60," says Schaefer.

Locating the mutation was the first step in determining how it reduces circulating HDL. According to Schaefer, his group is in the process of decoding the abnormal gene with the mutant portion. "Within the next year," he says, "we hope to know precisely how the mutation affects the production of apolipoprotein A-1, which, in turn affects the levels of HDL."—By **Judy McBride,** ARS.

Jose M. Ordovas and Ernst J. Schaefer are at the USDA Human Nutrition Research Center on Aging, 711 Washington St., Boston, MA 02111. ■

New Cotton-Processing System Saves Energy, Cuts Pollution

The machines for removing cotton lint from cottonseeds have steadily improved since Eli Whitney patented the first cotton gin in 1794. Now Agricultural Research Service researchers in Mesilla Park, NM, are speeding up this evolution even more to save energy, cut dust pollution, and in the process produce better quality lint.

Engineer Ed Hughs thinks they have accomplished their goal. The new ginning machine put together at the Ginning Research Laboratory takes seed cotton in one side and puts out clean cotton lint on the other side ready for baling. It eliminates the need for three separate machines and massive air ducts to move the cotton between these machines.

Without the air-handling system, electric power consumption is reduced.

Agricultural engineer Marvis Gillum at console of the prototype gin/cleaner that is designed to take the place of three presently used machines. (0586X582-3)

Hughs estimates a typical cotton gin could cut overall power costs 20 to 40 percent. Cyclone dust collectors now used in cotton gin buildings would be largely unneeded or smaller—saving power and equipment costs, as well as reducing chances for air and noise pollution.

Hughs does not expect the new combined gin and lint cleaner to replace existing equipment unless a cotton ginning operation is undergoing modernization. Gin numbers have dropped to about 1,700 in the United States, down from 2,800 about 10 years ago. "But overall capacity hasn't dropped that much," Hughs says. "This trend toward larger operations should make it easier for advanced equipment such as ours to gain acceptance."

The prototype did not come easily, says Hughs. "After much work and borrowing as many commercially available parts as possible, we had the combined gin-lint cleaner ready for tests last fall." These tests at Mesilla Park were successful. The quality of cotton fiber coming out of the machine was generally as good as that from three separate conventional machines.

ARS textile technologist Charles K. Bragg at Clemson, SC, will do further testing during 1986 to verify that fiber from the new machine is as good as conventionally processed fiber for making into textiles.

The next step will be for the engineers to connect a computer to the machine to further improve efficiency. The computer could control how fast raw seed-cotton can be fed to the machine, check for proper moisture content to maintain highest quality, and control trash removal.—By **Dennis Senft,** ARS.

Ed Hughs is located at the USDA-ARS Southwest Cotton Ginning Research Laboratory, P.O. Box 789, Mesilla Park, NM 88047. Charles K. Bragg is at the USDA-ARS Cotton Quality Research Station, P.O. Box 792, Clemson, SC 29631. ■

Tank Provides New

Centuries-old picklemaking techniques—in outdoor tanks of salt brine—may change as a result of U.S. Department of Agriculture research.

Ten companies throughout the nation are testing a process that relies on the old-time fermenting of cucumbers in brine but uses a new closed tank sealed from air and sunlight, says Henry P. Fleming, an Agricultural Research Service scientist at Raleigh, NC.

Currently, tanks are left open outdoors so the brine is exposed to sunlight, which prevents growth of molds, yeasts, and bacteria that can spoil pickles.

As extra protection outdoors, companies use more salt than necessary for picklemaking to guard against contamination from rainwater and foreign material and to prevent freezing. But the added salt must be removed before pickles are sold. That has been causing disposal problems for some pickle companies because waste brine may contain too much salt to meet federal water-quality regulations.

Closing the tank overcomes the old drawbacks, says Fleming, a food technologist. Salt usage is less. Sunlight is no longer needed since the tanks are sealed off from the air, creating an oxygen-free, or anaerobic, environment. Inside the sealed tanks, microorganisms that could cause spoilage cannot grow.

Picklemakers will also be able to control the environment in which desirable bacteria ferment cucumbers into pickles, Fleming says. These bacteria convert sugar in cucumbers to lactic acid, giving pickles their sour taste and preserving them.

Until now, the industry has not used the closed tanks because carbon dioxide gas, which forms during fermentation, must escape through the open tops. Otherwise, the gas can bloat pickles or even rupture the tanks.

Agency scientists discovered in the 1970's that the carbon dioxide could be removed by bubbling nitrogen gas through the brine. That technology

Home for Pickling

opened the way for the closed tanks, Fleming says.

Raleigh scientists are exploring new procedures to be used with the tanks. Microbiologist Mark A. Daeschel is studying ways to genetically engineer organisms to use in the closed tanks. These new organisms could ferment pickles with new textures and flavors, Fleming says.

As a precaution, biochemist Roger F. McFeeters is studying lactic acid-converting bacteria and potential problems that storing pickles at low salt concentrations could create.

Before 1940, virtually all pickles were made by brining, but now only about 40 percent are made that way. Two other pickling methods—pasteurization and refrigeration—have come into use since the 1940's.

But Fleming says old-style fermenting has economic advantages—rapid and temporary preservation, low energy costs, and spreading out the processing season to distribute labor and equipment costs.

The prospects of less salt, lower costs, and better products have excited picklemakers. The 10 companies this year are each testing at least two tanks, and if they are used commercially on a large scale they may "eventually revolutionize the way the industry produces pickles," he says.

The test tanks each hold 8,300 gallons and are 12 feet in diameter. Fleming, engineer Ervine G. Humphries of North Carolina State University, and the industry representatives designed the tanks. The companies paid for the tanks and for a pilot plant at the Mt. Olive Pickle Co., Mt. Olive, NC.

Fleming says the companies are test-marketing the pickles and that he is testing them to see how well they keep in storage.—By **Sean Adams,** ARS.

Henry P. Fleming is in USDA-ARS Food Science Research, Box 7624, North Carolina State University, Raleigh, NC 27695. ■.

Food technologist Henry Fleming (left) and cooperating North Carolina State University scientist Ervin Humphries in front of experimental closed-top pickling tanks at the Mt. Olive Pickle Company. (0686X749-15)


Above: Fleming at top of closed type of pickling tank which has a 30-inch diameter port through which the tank is filled and emptied. (0686X750-24)


At traditional open-top tanks used by the pickle industry, processing methods are discussed by Humphries (left); Fleming (center); and Douglas Brock, of the Mt. Olive Pickle Company, chairman of the Closed-Tank Task Force for Pickle Packers International. (0686X750-9)

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PATENTS

Papaya Wax Component Removed by Freeze Drying

Scientists have found a better way to remove cutin from the outer layer of papaya.

Cutin, a valuable component of the plant cuticle, serves as a barrier to harmful pests. It is being used in research to study cutinase, an enzyme produced by certain fungi that allows them to invade the cuticle and destroy fruit.

Previously, cutin was removed from papaya by immersing the fruit in heated solvent chemicals or by freezing the fruit and then rinsing it in hot water and scraping its outer surface.

With the new process, the papayas are freeze-dried so that the inner fruit shrinks and the outer, cuticle layer becomes separated. Then the cutin is mechanically brushed from the surface. The new method is less laborious than the old and eliminates the need for hot solvent chemicals.

For technical information, contact Harvey T. Chan, Jr., at the USDA-ARS Hawaiian Agricultural Experiment Station, Waiakea Farm, P.O. Box 917, Hilo, HI 96720. *Patent No. 4,421,775, "Method for Removing the Outer Waxy Cutin-Containing Layer From Papaya."* ■

Purple Color Signals Almond Contamination

A toxin in almonds can now be detected by a distinctive, fluorescent purple that shows up when the shelled nutmeats are exposed to ultraviolet light. The telltale color is unmistakable evidence of aflatoxins, highly toxic compounds that are produced by a mold. Toxin-free kernels show up as a fluorescent white, blue, or yellow.

The incidence of aflatoxins in almonds is very low, about one out of every 26,500 almonds. Almond producers, as well as state and federal agencies, regularly analyze random samples of raw and roasted almonds and almond products for the toxin.

The discovery of the link between the purple tint and the toxin paves the way for future development of electronic detectors, specially calibrated for safe, simple, and rapid recognition of the distinctive purple color in contaminated nuts.

Although such detectors might not be able to screen nuts that have their thin brown outer skin (pellicle) intact, these nuts are the least likely to contain any toxin. Electronic detectors are already used on production lines to sort out broken or otherwise damaged almonds. For technical information, contact John E. Schade, USDA-ARS Western Regional Research Center, 800 Buchanan, Albany, CA 94710. *Patent No. 4,535,248, "Method for Detecting Aflatoxin in Almonds."* ■

Debittering Citrus Juice With Cyclodextrin Polymers

See "Sugar Byproduct Removes Bitterness From Grapefruit Juice," p.4, for information on Patent Application Serial No. 526,753, "Method of Debittering Citrus Juice With Cyclodextrin Polymers."

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Copies of existing patents may be purchased from the Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, Washington, DC 20231. Copies of pending patents may be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. ■